IN THE SPECIFICATION:

Please substitute the following replacement paragraphs as indicated on the following pages.

Page 7, the paragraph beginning at line 25

Detailed Description

Figure 1 shows a conventional double faceted knife blade 1 with two faces 3 that terminate at facets 2, each of which [[are]] <u>is</u> formed at an angle A, Figure 2 relative to the blade faces 3. Generally each of the facets [[are]] <u>is</u> sharpened at angle A and meet at the edge. The character of the edge itself depends on the means used to sharpen the facets; however, if the facets are ground by conventional means a burr 4 will be created along the edge as seen in Figures 3 and 4, the latter being a very large enlargement of the circled area, Figure 3, of the edge itself. Figure 4 is the view of a freshly sharpened edge, showing a series of individual burr structures bent almost perpendicular to the center line of the two facets. Figure 5 shows the facets 2 and burr remnants 4 along the same knife edge of Figure 4 as they might appear after the facets have been in forced rubbing contact several times at a consistent and precisely controlled angle with reference to the plane of a hardened surface, moving in a direction nominally aligned with the linear edge of the blade. Figure 6 shows the edge structure after; (a) its back facet has been pressed repeated at the same controlled angle against the hardened surface; and (b) the front facet has been pressed similarly against the hardened surface.

The exact nature of these edge transformations depends of course on the pressure applied to the edge against the hardened surface, the relative angle between the plane of the facet and that of the hardened surfaces and the number of strokes against the hardened surface. Most of the original burr structure will have been removed at this point and the desired microstructure begins to develop along the edge.

Page 14, beginning at line 30

Figure 10 represents a precision blade sharpening means with sufficient accuracy to sharpen a knife before it is passed through a precise edge conditioning apparatus. It contains two precision angle guide surfaces 8 and 8a set at angle A relative to the plane 11 of a sharpening abrasive layer on the face of rotating disks whose surface are shaped, for example as sections of fustrated-cones. A knife blade 1 positioned with its face 3 resting on guide plane 8 will be sharpened by this means creating a facet 2 whose plane will be created precisely at angle A relative to the face 3 of the blade. The abrasive coated disks 9 and 9a shown here rotate about their mounting shaft 10 driven by a motor, not shown. The disks are free to move slidingly on [[Shaft]]<u>shaft</u> 10 against spring 14 on shaft 10 when the disks are displaced from their rest position established by stops 12. After a facet is created on the first side of the blade as shown, the blade can be moved to guide plane 8a where the second facet can be created by the second abrasive coated disk 9a at angle A relative to the opposite guided face 3 of the blade. Sharpening devices of this sort are described in greater detail in earlier U.S. patents of these inventors.

Page 16, beginning at line 27

Figure 12 shows simplistically the advantage of using an elongated guide surface 7 and the long faces of the blade 3 as reference surfaces in order to position the edge facet 2 of blade 1 at a precisely controlled angle relative to an established contact plane of the hardened surface member 13. The intimate contact of the elongated ~~planer~~ planar area 3 of the back side face of the blade with the rigid plane 7 of sufficient length, width and area does insure precise control of the angular position of the blade and its facet relative to the predetermined orientation of the hardened contact surface 5 on the member 13. The greater the length and width of the guide surface, up to the blade size the greater the precision of the angle control will be. Preferable to insure sufficient angular accuracy, the length of the guide surface is not less than 20% of blade length but generally not less than about one inch. By controlling the angle between the facet and the hardened surface by this means, the angle is remarkably consistent and free of variations due to features such as blade thickness at the edge and variations of blade width along the length of the blade. It is evident that the precision of the angle control described above in Figure 12 using an elongated plane will be far better than that obtainable for example with a single round guide rod angularly aligned to a hardened surface to serve as the angled guide adjacent to the

hardened member 13. Two rods can be set at a common angle and spaced apart to define a plane to guide the blade but an uninterrupted surface is more accurate and more convenient over the full blade length. Random variations of only a few degrees in alignment of the edge facet and hardened surface will affect noticeably the quality of the microstructure along the blade edge. Precise angle control can be obtained of course by clamping the blade in a precise mechanical arm where the precision of the arm mechanism provide the required angular accuracy. Such complex means, however are impractical in the home or industrial kitchen or butchering environments and they represent unnecessary complexity to achieve the required accuracy.

Page 18, beginning at line 3

Figures 13 and 14 show one structure for a precision manual edge conditioner in accordance with the principles detailed above. Hardened members 13 are mounted nominally centrally between elongated knife guides 17 in a physical structure 15 which has an attached handle 16 that can be conveniently gripped with one hand while the face of blade 1 is drawn alternately with the other hand along the surface of guides 17. The length of guide 17 is adequate to insure very accurate alignment of the blade edge with the guide and the contact surface of hardened members 13. The use of two hardened members 13 is optional but it has the advantage that in the structure 15, the edge conditioner can be used conveniently by either a right or left handed operator and have the advantage of two hardened members for more rapid sharpening of some blades and the advantage that the entire length of edge can be conditioned up to the bolster or handle. Alternatively a single hardened member 13 can be similarly located between the guides. Members 13 are sized and located as shown centrally between the guides so that the edge of the blade facet will contact one or both of the members as the blade is drawn along the elongated guide surface and pressed against the contact surface of the hardened member. The angle of the elongated blade guides can be selected so that the angle between the planes of the edge facet and the plane of the

hardened surface is optimized for the blade whose edge is being conditioned. Mechanical means for example such as in Figure [[16a]] 16A can be incorporated to permit adjustment of the angle of the guide means so that angle C, Figures 11 and [[16a]]16A, can be optimized for the particular angle of the facets of the blade edge being conditioned. Figure 16A illustrates the mechanical means for adjusting the angle of the guide means. As shown therein each guide 7b is pivotally mounted at 43 to support member 19. A spring 41 urges each guide 76 to rotate in a direction away from hardened member 13. A stop member 42 is threadably mounted through support member 19 to limit the rotational movement of guides 76. Thus the spring force of each spring 41 urges each guide 7b against stop 42 to establish angle C. That angle is adjusted by adjusting the position of stop member 42. Alternatively as described subsequently a combined precision knife edge sharpener, either manual or powered together with a precision manual edge conditioner provides in one apparatus control of both angles A and C and insures optimum results of the edge conditioning step.

Page 23, beginning at line 5

The mechanism of Figures 13, 14, 15, 16 and [[16a]] 16A is simply one example of the configurations that can be used to carry out the precision edge conditioning process while maintaining close control of the angle B, Figure 11, between the plane of the facet 2 and the plane of the hardened member 13. The shape of the surface and the shape of the hardened member can be varied widely to accommodate alternative means of guiding the blade accurately and of establishing precisely the angle B between the surface of hardened member 13 and the blade facet 2. Clearly a variety of alternate restraining means including wire and leaf springs can be used to position the hardened member and to allow but offer resistance to controlled displacement of hardened members. Alternative means can be used to permit movement of the hardened members to expose fresh areas on their surfaces which can be used to condition the edge. A sharpener incorporating both a precision sharpening stage and the edge conditioning mechanism shown in ~~figures~~ Figures 15 and 16 permits accurate control of angle B and the creation of edges with optimal conditioning as described earlier.

<u>Page 25, beginning at line 10</u>

A high degree of precisely repetitive micromanipulation is necessary to create this favorable type of edge. In addition to the need to establish precisely the angle between the surface of the facet and the surface of the hardened material at the point of contact, it is critical to insure that this angle of attack is maintained on each and every stroke of the knife edge along its entire length. The angle of attack must be maintained with a ~~repetition decreasing~~ <u>repetitive accuracy</u> of approximately plus or minus 1 to 2 angular degrees. Such precise repetition is necessary to avoid seriously damaging the microteeth or altering the nature of edge structure being created along the edge. Further the pressure applied by the knife facet against the hardened surface must be optimized in order to avoid breaking off prematurely the newly formed microteeth. The force developed along the edge of the facets by the repetitive sliding contact smoothes the sides of the microteeth but stresses them and strains them in a manner that repeatedly fractures their support structure at a depth along the edge significantly below the apparent points of their attachment. This repetitive process leads ultimately to the removal of the microteeth and their replacement with a new row of microteeth created by the repetitive fracturing of the supporting edge structure below each "tooth". The amount of force exerted against the microteeth on

each stroke is dependent upon the downward force on the knife blade as applied by the user. It is important to realize that the localized force against the microteeth can be very large because of the wedging effect at the blade edge between the elongated angled knife guide and the hardened surface. The force that must be applied by the user is consequently relatively modest and certainly less than if the force had to be applied directly in the absence of a knife guide. It would be very difficult to apply consistently this level of force to the knife edge by any manual non-guided stroking procedure.

Page 27, beginning at line 8

As mentioned earlier, the hardened surface should not have an inherent tendency to abrade. The surface should not be coated with conventional aggressive larger abrasive particles of materials such as diamonds, carbides or abrasive oxides. These materials when in sizable particulate form typically have extremely sharp edges that give them aggressively abrasive qualities. However, these same materials are extremely hard and when prepared in large planar form and highly polished are essentially non-abrasive. The edge conditioning process disclosed here relies on precisely applied angular pressure by a hardened surface against the facet at its edge in order to repeatedly create and fracture a microstructure along the edge at the extreme terminus of the facets. The process of repeatedly rubbing the knife facet and edge structure against the harder surface stress hardness the facet adjacent to the edge, fractures the edge below the edge line and deforms the metal immediately adjacent to the edge. The metal along the lower portion of the facet adjacent the edge is deformed, smeared by the localized contact pressure and microsheared as a result of the very small differential angular alignment of the plane of the hardened surface and the plane of the edge facet. Thus the localized contact pressure slowly fractures the microteeth along an edge and slowly and selectively re-angles the lower portion of the

facet to conform closely to the plane of the hardened surface. It is clear that if the differential angular alignment is too great or if there is any true abrasive action at the edge the microstructure that otherwise would be slowly created and recreated will be prematurely abraded away and destroyed. The rate of facet deformation and metal removal adjacent the edge must be minimized in order that the microstructure has time to develop and be protected from direct abrasion. The amount of wear along the lower portion of the facet that can occur from the inherent roughness of the hardened surface in the low micron range appears acceptable. Surface roughness (as contrast to dimensions of small repetitive geometric features) greater than about 10 microns will in some cases depending on pressures and the rate of microtooth development be about the practical limit[[,]] in order that such roughness does not lead to excessive metal removal while the optimum microstructure is being created. Consequently it is important that the hardened surface not have significant abrasive quality.

The paragraphs beginning at page 28, line 21 and ending at page 31, line 14

Because it is important to control angle B between the plane of the sharpened facet along the edge and the surface at point of contact with the hardened surface, in the optimal situation it is important as described above to control both angle A of the facet (Figure 10) and angle C in the conditioning operation Figure 11 so that the difference angle B (angle [[A]] C - angle [[C]] A) is closely controlled. For this reason it is now clear that there is a major advantage to creating a single apparatus [[31]] 39 such as shown in shown in Figures 17 and 18 including a sharpening station and an edge conditioning station 26, each with precisely controlled angles A and C respectively. The sharpening stage can be either manual or powered but in this example the sharpening stage is powered, as activated by switch 32. The first (sharpening) stage 25 of this apparatus has elongated guide planes 23 each set at angle A relative to the blade face and the abrasive surfaces. The guide planes 24 in the second (edge conditioning) stage 26 each are set at angle C relative to the contact surface of hardened member 13. The first stage Figure 17 is shown with U-shaped guide spring 22 designed to hold the knife securely against elongated guide plane 23 as the knife is pulled along said elongated guide plane and brought into contact with sharpening disks 9 and 9a (Figures 10 and 18).

The U-shaped guide spring 22 <u>mounted to post 28</u> to hold the blade face securely against the guide surfaces 23 of Figure 17 is illustrated for the first stage 25 but is omitted only for reasons of clarity in the second stage 26. <u>Figure 18, however, shows in phantom the post 29 for the guide spring in the second stage 26.</u> This type of spring is described in U.S. Patents 5,611,726 and 6,012,971, the details of which are incorporated herein by reference thereto. It is preferable, however to have a similar knife guiding spring 22 in the second stage 26 extending along the guide length in order to insure that the face of blade 3 is held in intimate contact with the elongated guide plane. That in turn insures that the blade facet is oriented relative to the contact surface of member 13.

The hardened member 13 is supported on structure 19 that is positioned forward of drive shaft 34 or slotted to allow uninterrupted passage and rotation of shaft 34 which is supported at its end by bearing assembly 35 supported in turn by structure 37 attached to base 31. Structure 19 likewise is part of base [[32]] <u>31</u> or a separate member attached to base 31. Hardened member 13 supported by and threaded onto rod 18 in this example can be displaced laterally when contacted by the blade cutting edge facet, the amount of such displacement being controllable by selection of appropriate durometer and design of the O-Rings, 20. Alternatively member 13 can be mounted rigidly on structure 19,

to be immobile, but that alternative requires slightly more skill by the user to avoid applying excessive force along the cutting edge.

Experience with an apparatus as illustrated in Figures 17 and 18 demonstrated the distinct improvement of creating the edge microstructure under strict consistent conditions where the angular difference B, [[(A-C)]] (C-A), was accurately controlled by the precision elongated guides to fall within the range of 3-5°. The advantage of having the sharpening and edge conditioning operation in the same apparatus is clear since each of the angles A and C [[are]] is predetermined by the preset angle of the elongated guides. The sharpening process which must be designed to create full facets at the desired angle A can be carried out by any of the conventional means known to those skilled in sharpening including abrasive and sciving means. It was also observed that there is an advantage of using diamond abrasives in the sharpening stage in order to create rapidly precisely ground facets with a distinct burr. Diamonds are the most effective abrasive for sharpening and for cleanly removing the metal. Consequently diamonds create without overheating a very pronounced and cleanly defined burr along the edge of any metal regardless of its hardness. The process of creating an optimum microstructure along the knife edge depends upon starting with a blade that has been sharpened sufficiently to establish well

defined facets then by applying pressure at a low angular difference B alternately on one side, then the other of the edge until any burr remnants are removed leaving a microstructure along the edge. As this breakup process proceeds it can be interrupted and the knife can be used for slicing food or other objects and subsequently conditioned further to improve once again or further the cutting ability of the edge structure. This reconditioning process can be interrupted and repeated many times until the reconditioning process becomes so slow that it is desirable to resharpen the edge and start with newly formed facets. It is important to note that by maintaining a small angular difference B during this process, the edge can be reconditioned many times before it needs to be resharpened to create a fresh precision facet at angle A.

Page 32, beginning at line 29

Figures 19 and 20 illustrate a motor driven three stage edge conditioning apparatus that includes a sharpening stage 25 designed to operate at angle A, an edge conditioning stage, 26 designed to operate at angle C, and a finishing stage 27 using a very mild buffing or stropping action designed to operate at angle D which must be close to angle C, preferable within 1 or 2 degrees. All of these angles are the angle between the controlling guide plane of that stage and the angle of the contact surface of the abrasives 9, 9a, 38 and 38a or the surface of hardened member 13. In this apparatus Figures 19 and 20 the first stage [[26]] 25 might for example use abrasive disks 9 and 9a coated with 270 grit diamonds. The third stage disks 38 and 38a could be made of ultra-fine 3-10 micron abrasives, such as aluminum oxide embedded in a flexible matrix as described in earlier U.S. Patents 6,267,652 B1 and 6,113,476, the details of which are incorporated herein by reference thereto. In the third stage 27 the grit size preferably must be small (less than 10 microns) and the force of the restraining spring 40 or its equivalent must be exceedingly small, preferably less than 0.2 pounds, in order to avoid an action so great that the microstructure developed in Stage 2 would be prematurely removed or damaged.

Add the following paragraph on page 33 after the last line

Fresh areas of the surface on the hardened member 13 can be exposed by rotating the member on the threaded section of rod 18. While not shown, a hold-down spring such as spring 22 would generally be incorporated to press the face of blade 3 securely against the plane of elongated guides 24 in order to insure accurate angle control during the edge-conditioning process.

Figures 19 and 20 show the posts 28 and 30 for mounting the guide springs 22 for stages 25 and 27. Figure 20 illustrates in phantom the post 29 that would mount the guide spring for stage 26.